

Transport of halogenated VSLS from the Indian Ocean to the stratosphere through the Asian monsoon circulation

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Halogenated very short lived substances (VSLS, e.g. bromoform) are naturally produced in the ocean and emitted to the atmosphere. When transported to the stratosphere, these compounds and their product gases increase the stratospheric halogen burden and influence ozone and climate. The Asian monsoon circulation provides an effective pathway for air masses from the atmospheric boundary layer to enter the global stratosphere during boreal summer. The role of biogenic VSLS emissions from the tropical Indian Ocean and their entrainment into the stratosphere above India and Bay of Bengal has not been investigated yet, but is crucial in understanding chemical and dynamical processes controlling ozone concentrations in the tropical tropopause layer (TTL) and the stratosphere.

During the research cruises SO234-2 and SO235 from Durban, South Africa, to Malé, Maldives, on board RV SONNE in July-August 2014 we measured oceanic VSLS in the subtropical and tropical West Indian Ocean and calculated their emission strengths. In order to analyze the transport of VSLS in the atmosphere we use the Lagrangian transport model FLEXPART with ERA-Interim meteorological fields.

First, we investigate the direct contribution of oceanic VSLS to the atmospheric halogen budget based on emissions observed during the ship cruise. FLEXPART forward trajectories were initiated with observed bromoform emissions along the cruise track, prescribing a varying atmospheric lifetime profile for bromoform between 11 and 18 days. For emission points within the influence of the Asian monsoon circulation, between 15°S and 3°S, about 2% of the emitted bromoform was entrained into the stratosphere.

Furthermore, we analyze the coupling between the oceanic source regions and the monsoon anticyclone in the TTL above the Asian continent during boreal summer. Trajectory ensembles released at the West Indian Ocean surface mainly enter the stratosphere above the Indian subcontinent and the Bay of Bengal. This is the region of where the Asian monsoon anticyclone isolates tropospheric air masses and lifts them to the lower stratosphere. We calculated FLEXPART backward trajectories, starting from different heights in this region, to investigate the major source regions for air masses reaching the stratosphere.